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ORIGINAL RESEARCH **PAIN MANAGEMENT**

Acute effect of kinesiotaping applied to the first finger of the patients with rheumatoid hand

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ABSTRACT

Background & Objective: Rheumatoid arthritis (RA) is a crippling disease characterized by joint pains and joint stiffness. Kinesiotaping (KT) has been advocated to reduce local pressure and increase circulation, resulting in decreased pain in various conditions. We aimed to evaluate the acute effect of KT on pain, function, range of motion (ROM) and grip strength parameters in patients with rheumatoid hand.

Methodology: A total of 34 patients, 27 women and 7 men, diagnosed with RA were included in our study. All patients were divided into two groups; Kinesiotape group (Group KT) and control group (Group C), each consisting of 17 patients. Subjective pain intensity by Visual Analog Scale (VAS), ROM by goniometer, functional evaluation with the Grip Skill Test, hand grip strength by dynamometer, and finger grip strength by pinchmeter were evaluated. The patients in the Group KT were taped with the mechanical correction method and the patients in the Group C were taped with tensionless I tape. Applications were made on both dominant and non-dominant hands.

Results: The mean age of the patients was 54 ± 20 y. VAS score changes at the time of grasping were significant in both groups ($P < 0.05$), but Group KT was more effective for reducing pain and increasing grip strength. An increase was observed in the wrist and thumb metacarpophalangeal joint ROM in the Group KT ($P < 0.05$). No change was observed in the groups in hand grip strength and finger grip strength ($P > 0.05$). In the Grip Skill test, there was a significant difference after the application in both groups ($P < 0.05$), but there was no difference in between the groups ($P > 0.05$).

Conclusion: Kinesiotaping applied in rheumatoid hand patients was found to be effective in increasing functionality and joint range of motion, as well as reducing pain during gripping.

Abbreviations: KT – Kinesiotaping; RA – Rheumatoid arthritis; MCP – Metacarpophalangeal joint; ROM - Range of Motion; VAS - Visual Analog Scale

Key words: Hand function; Hand deformities; Kinesiotape; Kinesiotaping; Rheumatoid arthritis; Range of Motion, Articular; Visual Analog Scale

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1. INTRODUCTION

Rheumatoid arthritis (RA) is a chronic, systemic disease characterized by synovial inflammation. The wrists, metacarpophalangeal and proximal interphalangeal joints are often involved symmetrically and bilaterally. The hand and wrist joints are the first joints involved in the vast majority of patients with RA. Early diagnosis of RA is important because restrictions in daily living activities due to deformities will cause difficulties in people's lives in the future.[1] While 90% of patients with RA developed hand deformity before 2000, this rate has decreased to approximately 30% today. However, hand and wrist complaints are observed in almost all patients (94%).[2] Caput ulna syndrome, radial deviation of the wrist and zigzag deformity, ulnar deviation of the metacarpals, buttonhole and swan neck deformities, and tendon ruptures are the most common disorders in RA patients with hand involvement.[3]

Detailed evaluation is one of the prerequisites of treatment in patients with rheumatoid hand. In addition to demographic information of the patient, laboratory tests, radiological evaluation, goniometric evaluation, evaluation of muscle strength, evaluation of grip strength and functional evaluation are required. Rheumatic diseases constitute the largest group among musculoskeletal diseases that cause hand deformity. Therefore, it is important to establish and develop treatment options for the rheumatoid hand.

Although there has been no study on the use of the Kinesiotape (KT) technique in rheumatoid hand patients, some positive results have been pointed out in studies conducted to evaluate its clinical effectiveness in other disease groups, such as impingement syndrome and carpal tunnel syndrome. Among these effects, it regulates the function of weak muscles; regulation of excess edema and impaired circulation under the skin by activating the lymphatic and blood circulation systems; reducing pain through neurological suppression; facilitating the movement of fascia and tendons by reducing abnormal muscle tension. It provides reposition to subluxated joints, increases proprioception via cutaneous mechanoreceptors.[4] However, Csapo et al. explained in a meta-analysis evaluating the studies in the literature, that there is not enough data to evaluate the clinical efficacy on pain, muscle activity and range of motion (ROM) except for a few case reports and anecdotal studies that are not randomized, therefore there is a need for well-designed randomized controlled studies. In this meta-analysis study on KT in the literature, it is emphasized that the application is safe and easily tolerated by the patient.[5] Chang et al. investigated whether KT applied to the forearm affected maximal grip strength and feeling of power immediately after.[6] Three separate measurements were made on 21 healthy young athletes without taping, placebo taping, and kinesiology taping. In the results, no significant difference was observed in all three measurements in terms of maximal grip strength. However, a significant decrease in force sense errors was observed in the KT group. Based on these results, it was emphasized that the feeling of power can be increased with KT. It has been stated that this is especially important in competitive athletes because full hand strength control is important in these athletes.

In this study, it was aimed to evaluate the acute effect of Kinesiotape taping on pain, function, ROM and grip strength parameters in patients with RA level 2−3 and hand involvement.

2. METHODOLOGY

This study was a double-blind, randomized clinical trial conducted by Ethics Committee from April 2018 to October 2018 in the rheumatology unit of a university hospital in Turkey.

Inclusion criteria was; 18−60 y of age, diagnosed as Level 2−3 RA, no change in pharmacological treatment until 1 month before the study. Exclusion criteria; presence of acute disease, diagnosis of Level 4 RA, intra-articular or intramuscular injection application in the previous months, presence of hand-wrist surgery history in the last 6 months, non-rheumatoid hand deformity.

The sample size was calculated based on a previous study that gave an effect size of 0.8.[7] Taking an approximate value of the number of patients who applied to our rheumatology unit, the level of significance was determined to be 0.05 for the number of participants to be included in the study, and its power was 0.8. Sample size was calculated using G'Power version 3.1.9.2, which gave a sample size of 30 with 15 participants in each group. The patients were divided into two groups using simple randomization method. Considering the drop-outs, we determined each group as 17 patients. Blinding was ensured and the patients and the rheumatologist were unaware of the type of physiotherapy treatment application. Signed informed consent was obtained from every participant.

Socio-demographic information was recorded. Subjective pain assessment was evaluated with a Visual Analog Scale (VAS), ROM was evaluated with a goniometer, functional assessment was evaluated with the Grip Skill test, hand grip strength was evaluated with a dynamometer, and finger grip strength was evaluated with a pinchmeter.

The measurement of hand grip strength and finger grip strength to be used as an assessment is frequently used in the assessment of hand functions. Finger grip strength was found to be associated with anthropometric factors

such as forearm length and finger length.[7] Three measurements were made with a dynamometer for hand grip strength and a pinchmeter for finger grip strength and the averages were taken.

In addition, the Grip Skill test can also be applied, and this test was basically developed for cases with RA. It has three main components; filling the glass with water, holding socks, envelopes with paper clips. The maximum time allocated to each test is 60 sec. The time to complete the first and second tests is multiplied by 1.8 and added to the other values. The total score range is 10−279. A high score means impaired hand function. The mean score value in healthy individuals is 16.5 (range 11−20).

In this study, the mechanical correction method was used in the Group KT and the acute effect results were evaluated. In the Group KT, the thumb was taped with 50−75% tension to create a pulling force in the flexion and abduction directions. The application was performed with the patient in a sitting position with his arm supported by a pillow from the elbow. Evaluation parameters were evaluated before and one hour after the application, and the acute effect was examined. Both the dominant and nondominant hands of the patients were taped and the differences between the two hands were also examined. Sham application was applied to both dominant and nondominant hands in Group C patients. Sham taping was the bonding of I tape to the first finger without tension and did not contain any features.

Statistical significance was assessed at $P < 0.05$ (only interaction was assessed at $P < 0.1$) and all statistical analyses were performed using R (R software, version 4.0.5, packages: arsenal-nparLD-ggplot2, R Foundation for Statistical Computing, Vienna, Austria; http://r project.org) and SAS software (Version 9·3; packages: PROC MIXED, SAS Institute, Cary, NC, USA).

Analysis of VAS scores, ROM values, dynamometer and pinchmeter results and grip ability test scores were performed with non-parametric approach Brunner-Langer model (F1-LD-F2 design). Other measurements were analyzed with parametric approach linear mixed models (LMM) (includes: random intercept, unstructured covariance matrix and heterogenous residual variance for groups).

3. RESULTS

A total of 34 patients with rheumatoid hand, 7 males and 27 females, were included in the study. Thirty-two of the participants used the right hand, and 2 patients used the left hand dominantly.

There was no significant difference between the groups in the demographic characteristics including affected site, age, height, weight and body mass index ($P > 0.05$) (Table 1).

Table 1: Baseline characteristics of groups

Parameter	Group KT (N=17)	Group C (N=17)	P - value
Gender			
Female	12 (70.6%)	15 (88.2%)	0.398
Male	5 (29.4%)	2 (11.8%)	
Dominant Hand			
Right	16 (94.1%)	16 (94.1%)	1.000
Left	1 (5.9%)	1 (5.9%)	
Age	51.76 ± 11.53	55.35 ± 9.59	0.331
Height	163 ± 9.52	161.94 ± 7.73	0.518
Weight	73.94 ± 13.11	76.06 ± 14.38	0.657
BMI	27.74 ± 4.16	28.94 ± 4.94	0.449

Associations between two categorical variables were assessed with Fisher's Exact test. Study groups were compared with the independent sample t-test or Mann-Whitney U test for numerical variable at baseline.

The changes in the VAS scores questioned at rest and grip before and after the application for pain assessment

Table 2: Change of VAS over time between groups

VAS score	Group KT (N=17)		Group C (N=17)		P - value		
	pre	post	pre	post	Group	Time	Group:Time
VAS score at rest	1.35 ± 2.76	1.23 ± 2.48	2.05 ± 2.86	1.94 ± 2.68	0.327	0.395	1.000
VAS score during grip	3.05 ± 3.07	2.88 ± 2.97	4.47 ± 3.85	4.17 ± 3.66	0.241	0.002	0.469

Longitudinal analysis of VAS was performed to test time (pre-post), group (control-kinesio), hand (left-right) effects and interactions among them. Analysis of VAS was performed with non-parametric approach Brunner-Langer model (F1-LD-F2 design). VAS: Visual Analog Scale; Data given as Mean ± SD

Table 3: The comparison of pre-post change of ROM values between groups considering sides

Test	Group	Before	After	p values
Left wrist flexion ROM	Group KT	47.47 ± 17.36	53.23 ± 17.13	G: 0.217 **T: 0.045**
	Group C	56.47 ± 14.41	57.64 ± 16.01	I: 0.177
Right wrist flexion ROM	Group KT	44.76 ± 15.60	47.17 ± 18.99	G: 0.24 T: 0.273
	Group C	51.64 ± 18.45	54.05 ± 18.44	I: 1
Left wrist extension ROM	Group KT	39.94 ± 18.31	45.76 ± 21.05	**G: 0.003** T: 0.232
	Group C	59.82 ± 12.47	59.0 ± 9.15	I: 0.115
Right wrist extension ROM	Group KT	35.76 ± 14.75	38.82 ± 16.19	**G: 0.001**
	Group C	52.17 ± 11.03	54.70 ± 13.03	T: 0.163 I: 0.893
Left wrist ulnar deviation ROM	Group KT	22.17 ± 11.51	24.23 ± 12.80	G: 0.575 T: 0.196
	Group C	23.58 ± 7.54	26.58 ± 12.11	I: 0.808
Right wrist ulnar deviation ROM	Group KT	19.47 ± 10.89	23.41 ± 13.28	G: 0.248 T: 0.801
	Group C	28.70 ± 13.90	23.82 ± 14.10	**I: 0.024*** **(A:0.039.** B:−. C: 0.153. **D: 0.043)**
Left wrist radial deviation ROM	Group KT	17.88 ± 12.58	21.35 ± 12.12	G: 0.183
	Group C	21.52 ± 8.86	27.41 ± 11.73	**T: 0.007** I: 0.465
Right wrist radial deviation ROM	Group KT	18.29 ± 9.32	20.94 ± 6.32	G: 0.776
	Group C	17.52 ± 9.32	20.11 ± 11.30	T: 0.1 I: 0.985
Left MCP flexion ROM	Group KT	40.11 ± 19.28	52.88 ± 16.97	**G: 0.049** T: 0.022
	Group C	55.58 ± 15.60	57.05 ± 13.23	I: 0.065* **(A:0.015 .**B: 0.065 C:0.697 .**D: 0.013)**
Right MCP flexion ROM	Group KT	41.52 ± 19.40	50.17 ± 16.40	G: 0.218
	Group C	49.70 ± 20.57	55.58 ± 14.77	**T: 0.019** I: 0.641
Left MCP abduction ROM	Group KT	44.41 ± 13.33	55.35 ± 13.97	G: 0.958 T: 0.235
	Group C	51.88 ± 18.86	47.35 ± 18.96	**I: 0.006*** (A: 0.192. **B: 0.006** C:0.243. **D:0.010)**
Right MCP abduction ROM	Group KT	42.76 ± 13.13	49.29 ± 14.11	G: 0.087
	Group C	55.64 ± 16.13	52.52 ± 17.02	T: 0.502 I: 0.064* **(A:0.016.** B:− C:0.348. D:0.11)

Associations between two categorical variables were assessed with Fisher's Exact test. Study groups were compared with the independent sample t-test or Mann Whitney U test for numerical variable at baseline.

Table 4: Comparison of dynamometer, pinchmeter measurements before and after and between groups

Test	Group	Before	After	P values
Left hand grip strength	Group KT	30.52 ± 17.33	32.64 ± 19.76	G: 0.717 **T: 0.025**
	Group C	31.58 ± 14.61	35.70 ± 15.19	I: 0.455
Right hand grip strength	Group KT	28.29 ± 12.13	30.94 ± 15.24	G: 0.095
	Group C	37.17 ± 14.91	38.41 ± 15.17	T: 0.169 I: 0.612
Right pinchmeter measurement	Group KT	13.64 ± 5.23	14.76 ± 5.54	G: 0.572
	Group C	12.94 ± 2.58	13.88 ± 2.47	**T: 0.011** I: 0.819
Left pinchmeter measurement	Group KT	12.94 ± 4.58	14.29 ± 6.63	G: 0.447
	Group C	12.47 ± 2.62	12.58 ± 2.62	T: 0.203 I: 0.283
Left lateral pinchmeter measurement	Group KT	13.47 ± 5.39	13.82 ± 4.91	G:0.435
	Group C	12.70 ± 2.86	12.29 ± 3.75	T: 0.933 I: 0.277
Right lateral pinchmeter measurement	Group KT	13.64 ± 5.08	13.70 ± 3.88	G: 0.861
	Group C	13.64 ± 2.28	14.11 ± 2.26	T:0.605 I: 0.507
Left grip skill test	Group KT	23.24 ± 7.60	17.80 ± 4.23	**G: 0.0026**
	Group C	22.9 ± 9.31	19.1 ± 5.98	**T: 0.00011** I: 0.52
Right grip skill test	Group KT	21.5 ± 7.2	16.5 ± 4.12	**G: 0.0125**
	Group C	22.9 ± 9.91	19.8 ± 7.4	**T: 0.0038** **I: 0.00014*** ***A:0.001** B:0.107 C:0.1604 **D:0.0002**

Grip strength, pinchmeter measurement results, lateral pinchmeter measurement results, before and after comparison of grip skill test score were analyzed with the non-parametric Brunner-Langer model (F1-LD-F2 design).

in both the Control and Group KTs were similar (P > 0.05). VAS scores at rest did not differ significantly between groups, and VAS values did not change before and after the application (P > 0.05). Similarly, the VAS scores at the time of conception were not statistically significant between the groups, but the VAS score changes after the application were significant in both groups (P < 0.05) (Table 2).

The pre-post change in wrist flexion ROM was similar in both of the groups on the right and left sides and did not make a statistically significant difference (P > 0.05). Wrist extension ROM of the Group C was higher than the Group KT in both left and right hand comparisons and pre-post evaluation (P < 0.05). Radial deviation mean pre-post change was found to be increasing and significant for both groups and both hands (P < 0.05). For flexion MCP, the increase in the Group KT after the application was significant (P = 0.002), while the increase in the Group C was not significant (P = 0.432). In the abduction MCP analysis, pre-post and left-right interactions between groups were significant (P = 0.001 and P = 0.038 respectively). Group-time interactions were observed to be significant (left: P = 0.019 and right:

P = 0.062) in the analyses performed separately on the hands. In the pre-post evaluation, the mean of the Group KT increased in both hands, but the increase was significant only in the left hand (P = 0.005 and P = 0.085). When the right-left hand ulnar deviation averages were compared in the pre and post results, no significant difference was found (P > 0.05). Based on the values given, the Group KT showed an increase in the joint ROM values after the application, while the values of the Group C did not change or decreased after the application (Table 3).

While the mean of the left hand was higher and significant (P < 0.001) in the Group C for hand grip strength, there was no significant difference between the two hands in the Group KT (P = 0.446). There was no kinesio-control or superiority of one hand in pre-post change (time: side and group: time interactions P > 0.1). According to the finger grip strength results, while the increase in the left hand was not significant (P = 0.466), the increase in the right hand was significant (P = 0.005). In addition, there was no difference in the results between the Group KT and Group C (P = 0.784). For the measurement of lateral finger grip strength, the mean of the right hand was higher and significant in the Group C (P < 0.001), but no difference was observed between the hands in the Group KT (P = 0.956). Means of lateral finger grip strength were not significant between pre-post results and between groups (P = 0.375 and left: P = 0.489 and right: P = 0.867, respectively). Group KT and C both showed significant decrease in grip skill test (P < 0.001 and P = 0.021, respectively). However, the groups did not have an advantage over each other. Left hand dexterity was worse in both groups (P = 0.013) (Table 4).

4. DISCUSSION

Disruption of anatomical integrity, limitations in ROM, loss of muscle strength, possible sensory problems and pain, impair the ability to use hands in RA.[8] These are not independent factors. Deformity leading to a decrease in strength is an important factor that causes deterioration of hand functions.[9] In this study, we showed that hand deformities in RA and pain due to disease activity are associated with decreased hand grip strength, finger grip strength and hand functions. In the study of Günay et al. it was determined that pain was associated with the high Duruöz Hand Index (Cochin Hand Functional Disability Scale), along with deformities.[10] The results of the Grip Skill test, which we used to evaluate the functionality in our study, were successful in both groups with the decrease in the duration. We observed in this study that the acute effect of taping would have a positive impact on functionality in people with hand deformity due to RA. We managed to find only one study by Chang, Chou and colleagues that analyzed the effect of KT on maximum grip strength.[6] They concluded that KT caused no change in maximum grip strength. Similarly, our research results show that KT application does not change the maximum grip strength one hour after the application. We found that the decrease in grip strength negatively affected activities of daily living and was associated with disability. Active ROM is affected by decreased muscle strength as well as deformities and conditions where joint integrity is compromised, such as narrowing of the joint space. Disruption of anatomical integrity, limitations in ROM, loss of muscle strength, possible sensory problems and pain impair the ability to use hands in RA.[8] Tastekin et al. measured finger grip strength together with hand grip strength in RA patients,[11] and similar results were obtained with our study. The limitation of joint ROM and deformities, which are also seen in our patient group, cause significant problems in the ability to use the hand. These deformities and the ROM limitations resulting from joint damage together lead to impaired hand functions of the patients and difficulties in daily living activities. Even though it was aimed to improve this existing condition with the taping application, its acute effects could not be found to have an effect on the ROM of the joint. So et al. reported that pain had a greater effect on disability and quality of life than radiologically detected joint damage.[12] They reported that the biggest problems of the disease in patients with RA were pain and physical limitation. In this study, we found positive results with the reduction of pain during gripping with the taping application we made and we think that it will have a positive effect on the daily life of the person.

As a result; hand joint ROM, hand grip strength and functionality are negatively affected by disease activity in RA. For this reason, the acute effect of taping in rheumatoid hand patients was found to be effective on increasing functionality, increasing ROM and reducing pain during grip. Taping should be considered as a method that can be applied in addition to the physiotherapy procedures to be applied in rheumatoid hand patients.

5. LIMITATIONS

Limitations of this study, long-term results of kinesiotape application were not evaluated. Evaluation and treatment in a larger population is recommended.

6. CONCLUSION

In conclusion; the acute effect of Kinesiotaping applied in rheumatoid hand patients was found to be effective in reducing pain during grip as well as increasing functionality and range of motion.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Conflict of interest

The study did not utilize any grant or external or industry funding.

10. Authors' contribution

ÖBÇ: Conceptualization, Methodology, Validation, Investigation, Resources, Writing, Visualization

SN, DB: Conceptualization, Methodology, Supervision, Project administration

SÖ: Data analysis

Vİ: Supervision

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